Geophysical Research Abstracts
Vol. 21, EGU2019-4633, 2019
EGU General Assembly 2019
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Mesoscale eddies in satellite sea surface salinity data and inferred eddy freshwater transports

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Mesoscale eddies dominate the kinetic energy of ocean circulation and contribute significantly to the ocean transport of heat and freshwater, key mechanisms that influence ocean properties and global climate. Satellites have provided a unique opportunity to observe mesoscale eddies due to their better spatiotemporal coverage compared to in-situ observing systems and, for nearly a decade, have included observations of sea surface salinity (SSS).

In this study, observations of SSS from NASA's Aquarius and SMAP, and ESA's SMOS satellite missions are evaluated to determine the extent to which the existing satellite data can be used to quantify and map eddy contributions to the ocean freshwater transport, based on their signal–to-noise characteristics. With a typical mesoscale eddy signal in SSS of 0.03-0.3 psu and the root-mean-square error of satellite retrievals of 0.3 psu, the signal-to-noise ratio barely approaches 1. On a statistical basis, however, very small standard errors, less than 0.01 psu, can be achieved for the average, composite eddies, resulting in robust estimates of the eddy-induced freshwater transports. This approach is applied near-globally to yield estimates in two dimensions.

In the tropics and mid-latitudes between approximately 45^{o}S and 45^{o}N, estimates of the eddy freshwater transport from the three satellites demonstrate a consistent and physically meaningful picture. Estimates start to diverge at higher latitudes resulting, presumably, from a dramatic increase in the level of noise in satellite retrievals (poor sensitivity of the L-band radiometer to SSS in cold water) and/or resolution issues (the eddy length scales generally decrease with latitude). Despite the limitations, our results demonstrate that the role of mesoscale eddies in the ocean freshwater transport can begin to be assessed from existing satellite data. We also discuss spatial patterns of the eddy freshwater transport resulting from our computations.